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The Impact of Training Distances (20 m, 50 m, and 70 m) on Concentration and Anaerobic Endurance in Archery Sub-Elite Athletes

El impacto de las distancias de entrenamiento (20 m, 50 m y 70 m) en la concentración y la resistencia anaeróbica en atletas sub-élite de tiro con arco

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Abstract. This study aims to investigate the effects of a new training method for archery athletes with different distances, namely 20 meters, 50 meters, and 70 meters, in improving concentration and anaerobic endurance. The pre- and post-control group design was used in this study with the sample selection method using the purposive sampling technique. The criteria for participants in this study include: actively practicing archery, aged 14-20 years, having at least 5 years of archery competition experience, domiciled in East Java Province, not injured, and willing to participate in the study until the end. 40 sub-elite archery athletes (20 males, 20 females) became participants in this study and were divided into 4 groups: conventional training (CON), training with a shooting distance of 20 m (NEAR), training with a shooting distance of 50 m (MID), and training with a shooting distance of 70 m (LONG) training groups. Each group underwent a 12-week training program specific to their assigned distance. The instrument used to measure concentration is the standardised archery mirror drawing test and to measure anaerobic endurance using the RAST test instrument. The results of the paired sample t-test analysis showed that in the anaerobic endurance variable, the NEAR, MID, and LONG groups had a p-value <0.05, while the CON group had a p-value > 0.05. In the concentration variable (time), all groups had a p-value <0.05, while in the concentration variable (error), there were only two groups (NEAR and CON) that had a p-value <0.05. The Anova Test results showed a significant difference between the CON and MID groups and CON and LONG ($p <0.05$) in the anaerobic endurance, while in the concentration (time) there was a significant difference between the CON and LONG groups and NEAR and LONG ($p<0.05$). In conclusion, the MID and LONG groups significantly improve anaerobic endurance and concentration, two important factors for archery success. Longer training distances appear to have a more pronounced effect on concentration.
Keywords: Archery; sub-elite athletes, training distance, concentration, anaerobic endurance

Resumen. Este estudio tiene como objetivo investigar los efectos de un nuevo método de entrenamiento para atletas de tiro con arco con diferentes distancias, a saber, 20 metros, 50 metros y 70 metros, en la mejora de la concentración y la resistencia anaeróbica. El diseño del grupo de control pre y post se utilizó en este estudio con el método de selección de muestra utilizando la técnica de muestreo intencional. Los criterios para los participantes en este estudio incluyen: practicar tiro con arco activamente, de 14 a 20 años, tener al menos 5 años de experiencia en competición de tiro con arco, domiciliado en la provincia de Java Oriental, no lesionado y dispuesto a participar en el estudio hasta el final. 40 atletas de tiro con arco de sub-élite (20 hombres, 20 mujeres) se convirtieron en participantes en este estudio y se dividieron en 4 grupos: entrenamiento convencional (CON), entrenamiento con una distancia de tiro de 20 m (NEAR), entrenamiento con una distancia de tiro de 50 m (MID) y entrenamiento con una distancia de tiro de 70 m (LONG) grupos de entrenamiento. Cada grupo se sometió a un programa de entrenamiento de 12 semanas específico para su distancia asignada. El instrumento utilizado para medir la concentración es el test estandarizado de dibujo en espejo de tiro con arco y para medir la resistencia anaeróbica utilizando el instrumento de test RAST. Los resultados del análisis t de muestras pareadas mostraron que en la variable resistencia anaeróbica, los grupos NEAR, MID y LONG tuvieron un p-valor $<0,05$, mientras que el grupo CON tuvo un p-valor $>0,05$. En la variable concentración (tiempo), todos los grupos tuvieron un p-valor $<0,05$, mientras que en la variable concentración (error), solo hubo dos grupos (NEAR y CON) que tuvieron un p-valor $<0,05$. Los resultados del Test Anova mostraron una diferencia significativa entre los grupos CON y MID y CON y LONG ($p <0,05$) en la resistencia anaeróbica, mientras que en la concentración (tiempo) hubo una diferencia significativa entre los grupos CON y LONG y NEAR y LONG ($p <0,05$). En conclusión, los grupos MID y LONG mejoran significativamente la resistencia anaeróbica y la concentración, dos factores importantes para el éxito en el tiro con arco. Las distancias de entrenamiento más largas parecen tener un efecto más pronunciado en la concentración.
Palabras clave: Ejercicio de liberación progresiva del sprint; entrenamiento por intervalos de alta intensidad; capacidad anaeróbica; capacidad aeróbica; velocidad.

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Introduction

The sport of archery requires a considerable degree of physical fitness and focus because of the inherent characteristics of the activity. Archers must have the endurance to maintain accuracy over long periods of competitive shooting, which can involve up to 18 rounds with 6 arrows per round (Handayani et al., 2024). Highly developed anaerobic endurance and the capacity to sustain concentration throughout extended training sessions and competitive events are essential qualities for archers (Susanto *et al.*, 2021; Fitoni, Prasetyo and Prasetyo, 2023; Lau *et al.*, 2020). In archery, physical attributes such as muscular strength and cardiorespiratory endurance are essential, as players are required to fire a substantial quantity of arrows over a prolonged duration (Borges et al., 2020a; Shibasaki et al., 2017). Nevertheless, some athletes may not completely grasp the significance of physical training in enhancing their archery performance, instead concentrating exclusively on technique and precision. Recent studies indicate a strong correlation between physical fitness and concentration in archery. Research specifically shows that novice athletes' concentration and shooting accuracy improve with better physical conditioning (Humaid, 2014; Musa et al., 2016; Sobko et al., 2019). This indicates that training programs designed to enhance anaerobic endurance and concentration may be beneficial for sub-elite archers looking to improve their performance. One factor that may impact both concentration and anaerobic endurance in archery is the training distance used (Susanto et al., 2021). While longer training distances may help build overall endurance, they may also lead to increased fatigue and reduced concentration, potentially negatively impacting shooting accuracy (Susanto et al., 2021). Conversely, shorter training distances may help to maintain focus and energy levels, but they may not provide sufficient anaerobic conditioning (França et al., 2022; Ramezani & Hosseini, 2019).

To better understand the interplay between training distance, concentration, and anaerobic endurance in archery, further research is needed. This study aims to investigate the impact of different training distances (20 m, 50 m, and 70 m) on concentration and anaerobic endurance in sub-elite archery athletes. The findings of this study could inform the development of more effective training programs for sub-elite archers, potentially leading to improved performance in competitive settings.

Methods

Study Design

This research is a quantitative experimental study that utilises a pre and post control group design. The purposive sampling technique was used to determine research participants and divided them into four groups randomly: conventional training (CON), training with a shooting distance of 20 m (NEAR), training with a shooting distance of 50 m (MID), and training with a shooting distance of 70 m (LONG) training groups. In this study, we define sub-elite athletes as youth athletes who have achieved national-level achievements and have entered the East Java provincial training center.

Subjects

A total of 40 sub-elite archery athletes (20 male, 20 female) were recruited to participate in this study. Participants were obtained using the purposive sampling technique, where the required criteria were actively practicing archery, aged 14–20 years, having at least 5 years of archery competition experience, domiciled in East Java Province, not injured, and willing to participate in the research until completion.

Treatment Procedure

Each group underwent a 12-week training program specific to their assigned distance. The conventional group (CON) did the exercises as usual, without a specific program. However, unlike the other groups, the conventional group performed the exercises at a distance of 70 m without any provisions. The NEAR group performed training sessions at a 20 m distance, the MID group at 50 m, and the LONG group at 70 m. Training sessions consisted of 3 sets of 36 arrows per session, 3 times per week with recurve bow. Implementation of one training session with the provision that one arrow may not be released for more than 10 seconds. If releasing one arrow takes longer than 10 seconds, we still add up the arrows and record the time deficit. If, in the process of releasing one arrow, it takes less than 10 seconds, the arrows are automatically added up, and a note is made regarding the excess time as a plus value. The process of releasing one arrow, starting with setting, drawing, anchoring, and releasing, should not take more than 10 seconds, so that anaerobic endurance and strength increase.

Instrument and Data collection

Concentration was assessed using a standardized archery mirror drawing test. To implement the mirror drawing test, the participant must sit comfortably in front of the concentration test tool. In the mirror drawing concentration test tool, there is a mirror that reflects a pattern in the form of a star, and the participant must focus on the reflection without looking directly at the original pattern. The tester records the time it takes the participant to complete the task following the direction of the mirror reflection pattern and also pays attention to any mistakes made (for example, if the line does not follow the correct pattern). This test is used to assess visual concentration, reaction speed, and eye-hand coordination, which are very important in improving the accuracy and consistency of shooting in archery (Alrubaye et al., 2023).

Anaerobic endurance was measured using the RAST Test, which evaluates fatigue index. The RAST test is performed by performing six maximum sprints of 35 meters, with a 10-second rest between each sprint. Before starting the test, participants perform an adequate warm-up, including dynamic stretching and light jogging, to reduce the risk of injury and prepare the body optimally. Each sprint must be performed with maximum effort, and the time required to complete each sprint is recorded. The time data is then used to calculate maximum power, average power, and fatigue, which provide an overview of the athlete's anaerobic ability and anaerobic endurance (Rusdiawan et al., 2020). Participants completed all assessments before and after the 12-week training program.

Statistical analysis

The analysis techniques used include descriptive statistics, normality tests, homogeneity tests, Anova tests, and post-hoc LSD tests. All statistical tests are conducted using Microsoft Excel 2016 and SPSS version 25 software.

Results

The descriptive analysis results' mean and standard deviation values correspond to the characteristics of all participants in this study. Some data to show the characteristics of

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the participants include gender, age, competition experience, height, weight, body mass index, and length of the right and left arms. Table 1 displays the results of the descriptive analysis pertaining to the participants' characteristics.

Table 1.
Characteristics of participants

Characteristics	Group								p-value
	NEAR		MID		LONG		CON		
	n	Mean±SD	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Gender:									
Male	7	-	2	-	5	-	6	-	-
Female	3	-	8	-	5	-	4	-	-
Age (years)	10	17.50 ± 1.58	10	17.50 ± 1.84	10	17.70 ± 1.49	10	17.40 ± 1.90	0.983
Practicing Experience (years)		9,50 ± 1,51		9,30 ± 1,64		9,60 ± 1,43		9,40 ± 1,78	0.978
Competitive Experience (years)		7.60 ± 1.35		7.40 ± 1.43		7.80 ± 1.23		7.70 ± 1.42	0.924
Height (m)		161.20 ± 7.16		160.60 ± 6.82		160.90 ± 7.71		161.50 ± 6.92	0.993
Weight (kg)		61.31 ± 14.66		60.86 ± 14.60		60.36 ± 8.01		61.00 ± 11.24	0.088
BMI (kg/m2)		23.36 ± 4.10		23.35 ± 3.97		23.38 ± 3.17		23.26 ± 3.14	1.000
Arm Length (cm):									
Left		84.75 ± 6.37		83.10 ± 4.56		83.25 ± 4.64		84.10 ± 3.70	0.863
Right		85.00 ± 6.00		84.44 ± 3.86		84.30 ± 4.60		85.10 ± 3.21	0.972

Significant difference at p<0.05

Table 1 describes the characteristics of the participants in the study, divided into four groups: NEAR, MID, LONG, and CON, each consisting of 10 participants. Based on the data analysis, there were no significant differences in various demographic and anthropometric variables between groups. The age variable showed similar means across groups, ranging from 17.40 to 17.70 years (p = 0.983). Training experience and competition experience also did not show significant differences, with p values of 0.978 and 0.924, respectively, indicating that all groups had almost identical backgrounds in terms of the number of years of training and competition. The average height ranged from 160.60 to 161.50 cm (p = 0.993), while the average weight ranged from 60.36 to 61.31 kg (p = 0.088), and the average BMI across all groups was almost identical (p = 1.000). Left and right arm lengths were also measured, with results showing homogeneity between groups (p-values of 0.863 and 0.972, respectively). Overall, these data suggest that the participant groups in this study were sufficiently homogeneous that any differences in outcomes that emerged could be attributed to the intervention or treatment provided rather than to variations in baseline participant characteristics.

Table 2.
The concentration and anaerobic endurance values of each group have changed.

Variable	NEAR (n=10)			MID (n=10)			LONG (n=10)			CON (n=10)		
	Mean±SD		p (sig.)	Mean±SD		p (sig.)	Mean±SD		p (sig.)	Mean±SD		p (sig.)
	Pre	Post		Pre	Post		Pre	Post		Pre	Post	
Anaerobic Endutance	3.58 ± 2.18	3.07 ± 2.14	0.480	3.29 ± 2.07	1.68 ± 0.84	0.037	4.84 ± 2.35	2.95 ± 1.35	0.018	3.47 ± 2.78	3.71 ± 3.14	0.777
Concentration (time)	74.10 ± 25.07	62.20 ± 23.44	0.000	73.20 ± 20.96	60.10 ± 18.31	0.001	74.00 ± 25.94	54.80 ± 21.34	0.001	74.50 ± 19.11	47.00 ± 13.39	0.001
Concentration (error)	5.80 ± 4.57	2.50 ± 1.96	0.037	7.90 ± 6.08	4.20 ± 2.62	0.062	5.00 ± 5.64	1.80 ± 3.68	0.091	5.30 ± 8.39	1.70 ± 2.75	0.023

Significant difference at p<0.05

Table 2 shows that in the NEAR group, there was no significant change in anaerobic endurance after exercise (mean±SD: 3.58±2.18 to 3.07±2.14, p=0.480), while in the MID and LONG groups, there was a significant decrease in anaerobic endurance (MID: 3.29±2.07 to 1.68±0.84, p=0.037; LONG: 4.84±2.35 to 2.95±1.35, p=0.018). The control group did not show any significant change (p = 0.777). This decrease in value means that participants do not tire easily, indicating an increase in anaerobic endurance.

In terms of concentration, the time required to complete the task was significantly reduced in all groups, with very low p-values (NEAR: 74.10±25.07 to 62.20±23.44, p=0.000; MID: 73.20±20.96 to 60.10±18.31, p=0.001; LONG: 74.00±25.94 to 54.80±21.34, p=0.001; CON: 74.50±19.11 to 47.00±13.39, p=0.001). Furthermore, the number of errors made during the concentration task decreased in all groups, with significant changes, especially in the NEAR and control groups (NEAR: p = 0.037; CON: p = 0.023), whereas the MID and LONG groups showed non-significant decreases (MID: p = 0.062; LONG: p = 0.091). These results indicate that training with different distances has a significant impact on improving concentration and increasing anaerobic endurance in sub-elite archers.

An ANOVA test was used to determine the extent of the differences in the averages of several groups (NEAR, MID, LONG, CON) on the anaerobic endurance and concentration variables (time and error). The anaerobic endurance variable, with a p (sig) of 0.044, and the concentration variable (time), with a p (sig) of 0.032, showed significantly different results. However, the concentration variable (error) did not demonstrate a significant difference p (sig) of 0.995. Moreover, the LSD test replicated the significant Anova test results, yielding the subsequent outcomes:

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Table 3.
Differences in anaerobic endurance and concentration (time) in each group

Variable	Group		*p* (sig)
Anaerobic Endurance	CON	NEAR	0.362
		MID	0.028*
		LONG	0.012*
	NEAR	MID	0.182
		LONG	0.096
	MID	LONG	0.731
Concentration (time)	CON	NEAR	0.831
		MID	0.199
		LONG	0.008*
	NEAR	MID	0.281
		LONG	0.014*
	MID	LONG	0.145

Significant difference at $p<0.05$

Table 3 reveals significant differences in the anaerobic endurance variable between the CON group and the MID group ($p = 0.028$) and LONG ($p = 0.012$), suggesting that training at medium and long distances influences anaerobic endurance differently than the control group (CON). There was no significant difference between the NEAR group and the other groups, or between the MID and LONG groups.

In the concentration variable (time), significant differences were found between the CON and LONG groups ($p = 0.008$) and between NEAR and LONG ($p = 0.014$). This shows that training at long distances has a more significant effect on increasing concentration compared to the control and short distance groups. No significant differences were found in the concentration variable (error), with a p value of 0.995, indicating that variations in training distance did not significantly affect concentration values.

These results confirm that certain training distances affect athlete performance in terms of anaerobic endurance and time concentration, with training at longer distances showing a more prominent effect.

Discussion

The reduction in fatigue levels, indicated by improved anaerobic endurance, was more pronounced in athletes training at 50- and 70-meter distances. This may be due to the increased physical demand and adaptation required at longer distances. The findings support the hypothesis that different training distances have varying effects on anaerobic endurance and concentration. Training at medium (50 m) and long (70 m) distances appears to be more effective in enhancing anaerobic endurance compared to conventional training or training at shorter distances (20 m). The increased physical demand associated with longer-distance shooting may elicit specific physiological adaptations that enhance the archers' ability to sustain high-intensity efforts for extended periods (Prasetyo and Prasetyo, 2023; Mon-López *et al.*, 2019; Ramezani and Hosseini, 2019).

One potential explanation for this phenomenon is the metabolic demands of longer-distance archery training (Açıkada et al., 2019). Drawing and holding the bow at greater distances requires more muscular effort and energy expenditure, resulting in increased anaerobic metabolism and anaerobic endurance (Borges et al., 2020b; Shibasaki et al., 2017). Furthermore, the physical challenges of maintaining a stable stance and accurately tracking the target over longer distances may contribute to the development of core strength and balance, which are essential for effective archery performance (Dorshorst et al., 2022; Sarro et al., 2021).

In contrast, training at shorter distances may not provide the same level of physiological stimulation, as the physical demands are relatively lower. This suggests that a training regimen that incorporates medium- and long-distance archery may be more effective in enhancing anaerobic endurance, a critical component of successful archery performance. It is important to note that the optimal training approach may depend on the athlete's current skill level and stage of development. For beginners, shorter-distance training may be more appropriate to develop the fundamental skills and technique before gradually progressing to longer distances. This might be due to the higher physical demands placed on the athletes at these distances, promoting greater physiological adaptation.

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Disrupted concentration often leads archery athletes to make incorrect moves and skip necessary movements, significantly affecting their performance. However, the better the physical condition, the better the concentration to support accuracy in archery (Jannah et al., 2019; Komarudin et al., 2020; Verawati et al., 2020). Furthermore, training at 70 m yielded the best results, suggesting that longer training distances may enhance focus and sustained concentration, both of which are essential for archery. The error rate in concentration tasks also decreased, although this reduction was not significantly different across all groups. Longer training distances seem to have a more pronounced effect on improving concentration, possibly because they simulate the conditions of actual competitive events more closely, where athletes need to maintain focus over extended periods. The study highlights the importance of integrating varying training distances into training regimens to optimise the physical and cognitive aspects critical to archery performance. Archers engaged in 70-meter training must maintain a higher level of focus and attention to accurately hit their targets, as the increased distance introduces greater challenges in terms of wind, arrow trajectory, and the need for precise form and technique (Czyz & Moss, 2016). This heightened demand on cognitive resources can lead to measurable improvements in an archer's ability to concentrate, both during training and in competitive settings.

In contrast, shorter-distance archery, while still requiring concentration, may not provide the same level of cognitive challenge. As such, the progressive nature of archery training, with a gradual increase in distance, can be a powerful tool for enhancing an archer's ability to focus and maintain concentration over extended periods (Lu et al., 2021). The findings of a study examining the effects of progressive muscle relaxation on concentration in archery athletes at the UNIMED Club support this notion. The researchers found that athletes who engaged in 70-meter archery training exhibited greater improvements in concentration compared to those who trained at shorter distances (Verawati et al., 2020).

Additionally, a study on the effect of circuit training on physical fitness and archery accuracy in novice athletes further reinforces the importance of physical conditioning in supporting concentration. In conclusion, the scientific evidence suggests that 70-meter archery training can be a more effective means of improving concentration compared to shorter-distance training. Furthermore, studies have shown that the physical demands of 70-meter archery, including greater muscle engagement and higher energy expenditure, positively impact overall physical fitness (Setyawan et al., 2024). Lau *et al.*, 2020 have linked enhanced concentration and focus in athletic endeavours to improved physical condition.

The relationship between physical fitness and concentration in archery is well-established, as the better an archer's physical condition, the more they are able to devote their mental resources to the task at hand (Handayani et al., 2024; Verawati et al., 2020). Analysis of the factor structure of young archers' comprehensive preparedness reveals that developing concentration and attention span is crucial for achieving elite-level performance.

Conclusion

Training at middle (50 m) and long (70 m) distances significantly improve anaerobic endurance and concentration, two important factors for archery success. Longer training distances appear to have a more pronounced effect on concentration, possibly because they simulate real competition conditions where athletes need to maintain focus for longer periods of time. Therefore, coaches and athletes should consider integrating a variety of training distances into their training sessions, with a focus on the 50 m and 70 m distances to improve endurance and concentration. Regular assessment of the athlete's anaerobic endurance and concentration, allowing for necessary adjustments to the training distances. To maximize athlete performance improvements, it is also important to include targeted physical training alongside this distance training.

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