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How Does Circuit Plank Exercise Affect Arm Muscle Strength and Archery Accuracy

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Abstract: *Circuit plank training is expected to improve archery accuracy supported by the dominant component in archery. This research was an experiment using a one-group pretest-postest design that provided circuit plank training activities in as many as 18 meetings and was carried out three times a week. The study populations were 22 athletes in Yogyakarta, which were then filtered again to take 12 athletes as the study sample using purposive sampling techniques with the criteria of male athletes aged 16-18 years. The instrument of this study included the holding bow digit test and archery distance of 40 meters. The analytical techniques used were normality, homogeneity, and hypothesis tests. The hypothesis testing used a T-test, a statistical analysis technique that can be used to determine whether there is a significant difference between the two mean samples. The analysis of the arm muscle strength data resulted in a t-count value of (41,894) > t table (1.80) and a p-value of (0.000) < 0.05. Meanwhile, the archery accuracy analysis obtained a t-count value of (34,019) > t-table (1.80), and a p-value of (0.000) < 0.05. The results of the two t-tests showed that the t-count value > t-table showed an increase after being given treatment. There was an increase in the strength and accuracy of archery athletes after having circuit plank training and increased endurance component of the arm muscles.*
Keywords: *Circuit, Plank, Bodyweight Training, Archery Sports.*

INTRODUCTION

Indonesians, especially athletes, participate in a variety of sports. One of them is archery, which is one of the world's best sports, this activity is welcoming to all groups (Y. Prasetyo & Susan, 1999). Children to adults can do this sport for recreational activities and achievement (Sarro et al., 2021). Archery achievements do not prioritize gender because archery is not an absolute thing that determines the superiority of performance, which means that when at the same level, male athletes are not necessarily superior to women (Hasmawati et al., 2020). The world record of 144 arrows for the men's recurve number is held by Kim Woo Jin with a score of 1391, while the women's recurve Park Sung Hyun holds the number with a score of 1405 (Ertan et al., 2021). The data can prove that in the sport of archery, women can compete fiercely with men and even surpass male athletes' achievements.

Archery requires five components, namely: physical, tactical, technical, mental, and proper bow tuning, and archery is a sport that not only requires cognitive skills but requires a dominant physical aspect (Spratford & Campbell, 2017). This aspect supports archery accuracy (Dhawale et al., 2018), which is very important in the support of physical endurance and the strength of the arm muscles (Kolayis et al., 2014).

Muscle strength is the ability of a muscle or muscle group to perform work by bearing the weight it lifts (Mohd Saleh et al., 2022). Strong muscles work efficiently daily and improve the body's shape (Ergen et al., 2021). Muscles that are not trained for some reason, such as an accident, will become weak due to atrophy, and if this is left unchecked, the condition can result in muscle paralysis (Nasihul et al., 2022). Muscle strength is closely related to the neuromuscular system, which tells how much the nervous system can activate muscles to contract, so the more muscle fibers that are activated, the greater the muscle's strength (Sadeghipour et al., 2021). Various physical strength exercises need to be trained to improve the athlete's achievements, from the strength of the arms, shoulders, abdomen, and legs (Susanto et al., 2022). One piece of training that could be applied is plank variation training.

Plank exercises are isometric exercises that train strength, which involves the whole muscle maintaining the same body position, such as push-ups for as long as possible (Devries & Giangregorio, 2023). Isometric contraction is the increase in muscle tension when lengthening so that the length of the muscle is in a fixed or unchanged state (Barclay & Curtin, 2023). Isometric exercise was a popular form of strength training in the 1960 (Hahn et al.,

2023). Strength training in an isometric way is more effective for maximum training strength, muscle hypertrophy, and muscle injury healing programs (Hashim et al., 2011). The results of plank training carried out systematically, continuously, and regularly in several reps and sets will affect the strength and flexibility of coordination and shoulder muscles (Stojanović et al., 2023). The stronger and longer a person can perform plank movements, the better the strength of his shoulder muscles to improve physical condition.

The plank exercise makes the muscles contract strongly as a response to the static loading of the muscles involved (de Souza Ferraz et al., 2023). Such loading results in muscle hypertrophy, whose effect will increase muscle strength (Benavente et al., 2023). Muscle hypertrophy depends on the exercises performed. The muscle which will be large is the slow muscle. Hypertrophy caused due to exercise is usually accompanied by increases in myofibrils, actin filaments, myosins, sarcoplasms, and other supporting tissues (Brightwell et al., 2022),(Lim & Goh, 2022).

Based on the observation results and empirical facts, archery coaches only provided monotonous training and lacked an understanding of the physical condition training variety specifically for archery. Some athletes were bored when participating in training and still felt heavy when pulling bows, and also, athletes experienced tremors in the left hand. The tremor experienced affected the groping of arrows which caused a lack of archery accuracy. Some trainers considered that the physical condition training for archery branches was only on the field by shooting as many arrows as possible. The arm muscle strength data measured by the holding bow digit test showed an average of 8.3. If converted to the norm, these results fall into less. In detail from the data, 20 athletes produced 10% in the good category, 35% in the medium category, 45% in the less category, and 10% in the very less category.

The circuit method consists of several items or kinds of exercises that must be done within a particular time. After completing one exercise, the athlete moves on to another without any recovery time until the training is completed (Sari & Vakili, 2022). Circuit drills are exercises with many items and various posts that move between posts or items until the series of practice items are completed. Sports coaching does not depend on the rapid application of sequential processes but on the quality of the coaches' knowledge (Yachsie et al., 2023). In addition to tactics, techniques, and mentality, physical conditions are indispensable for improving achievement (J. L. Park, 2021). Strength is the dominant component in archery to support bow drawing in the set-up to the full-draw position. However, on the field, the coaches only focus on technique and pay little attention to the physical condition of the athlete. Only understanding technique, mentality, or tactics will not help to obtain high points if the arrow misses. Therefore, to strengthen the tactics, physical training also needs to be done (Friday et al., 2023). From the background above, it can be concluded that there was an effect of circuit plank training on the strength of the arm muscles and the accuracy of archery athletes.

METHOD

This experimental research applied one group pretest-posttest design, carried out in one experimental group without a comparison group. In this study, one group was given a plank variation exercise activity in as many as 18 meetings carried out three times a week. The study sample did a pretest first before later being given activity and a posttest after treatment. The population in this study were archery athletes in Yogyakarta as many as 22 athletes with a sample of 12 athletes who were determined using a purposive sampling technique with the criteria of athletes being male and aged 16-18 years. The instrument of this study was a holding bow digit test for arm muscle strength with arm muscle strength measured in units (Kg), The validity of endurance was 0.895 > r table of 0.344 (H. Prasetyo & Siswantoyo, 2019). The accuracy of archery by a distance of 40 meters distance with validity 0,895 > r tabel 0,344 and reliability 0,944 > 0,60 (Yacshie et al., 2022) was assessed by looking at where the arrows landed and comparing them with the determined target. The way to calculate the accuracy of archery was by performing 36 arrow shots and totaling the number of each arrow that process is called scoring.

The researchers collected data by conducting an arm muscle endurance test with a holding bow digit test instrument and archery at 40 meters. After that was a pretest. The sample was given an exercise treatment by doing a plank variation training with the circuit method.

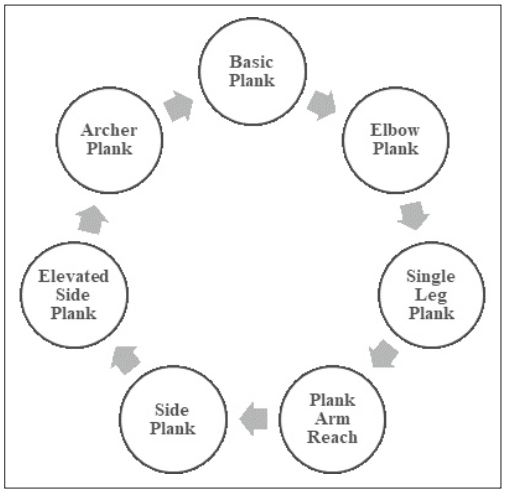

Figure 1. *Circuit Plank Exercise Programs*

The maximum heart rate determined the burden, using a formula to predict the maximum pulse rate. The result showed 220 – age (Z. Huang et al., 2023). The intensity was 70-75% with 30 seconds recovery, 3-6 reps, 3-4 sets, and 3-minute breaks between sets. The analytical techniques used were normality (kolmogorov-Smirnov technique), homogeneity (Levene statistic technique), and hypothesis testing applied a T-test, a statistical analysis technique that can be used to determine whether there is a significant difference between the mean samples.

RESULT

The hypothesis in this study is that there is an effect of Circuit Plank Exercise on Arm Muscle Strength and Archery Accuracy.

Table 1. *Descriptive Statistics Of Archery Strength And Accuracy*

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Arm Muscle Strength	12	176	633	444.92	142.005
Postest Archery Accuracy	12	425	668	549.00	81.981
Pretest Arm Muscle Strength	12	238	534	413.58	112.642
Postest Archery accuracy	12	270	598	437.08	112.788

Based on the data in table 1, the mean of pretest and posttest arm muscle strength increased, which meant that the data/research group experienced an increase in strength. The mean of pretest and posttest data on archery accuracy had also increased, meaning that the data/group also increased archery accuracy.

Table 2. *Normality Test Calculation*

Data		p	Sig.	Information
Arm Muscle Strength	pretest	0,745	0,05	Normal
	posttest	0,143	0,05	Normal
Archery Accuracy	pretest	0,387	0,05	Normal
	posttest	0,376	0,05	Normal

The results of table 2 this uni normality was obtained from the Shapiro-Wilk test. From the table above results, the pretest and posttest data had a p-value (sig.) > 0.05, which concluded that the variables were normally distributed.

Table 3. *Homogeneity Test Calculation*

Data	Sig.	Information
Arm Muscle Strength	0,397	Homogeneous
Exercise Meditation	0,354	Homogeneous

The results of the homogeneity test table 3 of this study can be seen in table 3 as follows: From table 3 above, the sig value of the pretest and posttest significance was > 0.05, so the data were homogenous.

Table 4. *Hypothesis Test*

Pretest – posttest	Df	T table	T count	P	Sig 5 %
Arm muscle strength	11	1,80	42.884	0,000	0,05
Archery accuracy	11	1,80	35.023	0,000	0,05

The data analysis table 4 of the arm muscle strength obtained a t-count value of (42.884) > t-table (1.80), and a p-value of (0.000) < of 0.05. The results showed that the t-count value was greater than the t-table. Thus, it meant that there was an influence of circuit plank training on arm muscle strength in archery athletes in Yogyakarta. Based on the analysis of archery accuracy above, the t-count value was (35.023) > t table (1.80), and the p-value was (0.000) < 0.05. The results stated that the t-count value was greater than the t-table. Thus, it can be interpreted that there was an influence of circuit plank on the archery accuracy of archery athletes in Yogyakarta. The results of the two t-tests showed that when the value of t-count > t-table, the results showed that the hypothesis was accepted.

ALTERATIONS

This research concluded that the increased arm muscle strength and archery accuracy resulted from circuit plank training exercises. The results were obtained when pulling the bow in the set-up position to the full-draw position. Athletes could pull the bowstrings until they touch the lips and the towing finger touch the chin. Therefore, circuit plank training exercises improved the strength and accuracy of this archery. Body weight training is the same as weight training and is only distinguished by different exercise models and variations. Body weight training can be done without using tools and body weight (Gwinnutt et al., 2022). This body weight exercise is often combined with the circuit method, which is an exercise that uses a form of movement summarized in several posts sorted according to the goals and rules set (Zheng et al., 2022); (Marpaung & Sari, 2022). Weight training with this circuit training system stimulates the muscles (Scoubeau et al., 2023).

Some of the muscle groups that were given stimulation in this study to be increased were: large muscle groups consisting of the pectoralis, hamstring, quadriceps, latticinio Dorsi, low back, biceps, triceps, and abdominal (Bastani et al., 2023). Plank weight training given according to the exercise's dosage, purpose, and dosage can significantly influence arm muscle strength (D'Onofrio et al., 2023). One of the essential elements in archery athletes' physical fitness is the arm muscles' strength (Liao et al., 2022). Excellent muscle strength is the basis for success in sports and the optimization of other physical abilities.

Strong muscles make daily work efficient and shape the body better (Kim & Kim, 2021). Muscle strength is related to the neuromuscular system, namely how much the nervous system can activate the muscles to contract, so the more muscle fibers are activated, the greater the strength the muscle produces (Vendrame et al., 2022); (Mohd Saleh et al., 2022). The plank body weight training program provides exercise movements from the first post to the last, is arranged in a circle, and after the time is up, the researcher gives a sign to stop, and the athlete moves to the next post. Furthermore, the movement of the seven posts is called one circuit. After the athletes do one circuit, they will be given a break for 3 minutes. A good training program increases the score. This can be obtained when the physical condition is supportive or is in shape and balanced with programmatic training (Serrien et al., 2018).

The research showed that archery accuracy was significantly increased along with good muscle strength. Pulling the tremor bow will decrease so that when releasing the arrow, the approval will be right on target so that it will obtain good points: X, 10, and 9. This archery accuracy uses a bow and arrow to aim at objects to stick to the point at which they are shot (Praseтyo et al., 2022). This means that every time the arrow is released, it should not be separated from the intended target (J. Park et al., 2022),(Lombard, 2022). Based on the results above, there was an improvement in archery accuracy due to the condition of the shoulders, strong arms, and good endurance, which caused the athletes not to feel tired. In contrast, the athlete felt light when pulling the bow, so the accuracy increased. From the monthly observations and scoring carried out once every month in Yogyakarta, archery accuracy was increased by looking at the average score obtained at a distance of 40 meters, 322-3 32. On the other hand, muscle endurance also increased, marking a significant increase experienced by the hand when grasping—being trained regularly increased strength and endurance.

Conclusion

Based on the research results and the data analysis, it was concluded that circuit plank body weight training exercises could increase arm muscle strength and archery accuracy, and the endurance component of arm muscles increases significantly.

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