The Effect of Aerobic Circuit Training on Muscle Resistance, Cardiorespiratory Endurance, and Accuracy Among Archery Athletes in Sport Laboratory School of Faculty of Sport Sciences at the Yogyakarta State University

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ABSTRACT: This study aimed to investigate the effect of aerobic circuit training on muscle resistance, cardiorespiratory endurance, and archery accuracy. The study was conducted using the one-group pretest-posttest design. The research subject of was 11 archery athletes of Selabora FIK UNY (Sports Laboratory School of Faculty of Sport Sciences at the Yogyakarta State University). The data were analyzed using the t-test with a significance level of 5%. The results of the analysis of the athletes' muscle resistance showed that the t-count value (13.124) was higher than the t-table value (2.28); the results of the analysis of the athletes' cardiorespiratory endurance showed that the t-count value (3.964) was higher than the t-table value (2.28); and the results of analysis of the archery accuracy showed that the t-count value (7.807) was higher than the t-table value (2.28). Since the t-count was higher than the t-table, the hypothesis was accepted and suggests that there is an effect of aerobic circuit training on muscle resistance, cardiorespiratory endurance, and accuracy among the archery athletes in Selabora FIK UNY. Thus, it can be concluded that aerobic circuit training has an effect on archery athletes' muscle resistance, cardiorespiratory endurance, and accuracy.

KEYWORDS: aerobic circuit training, muscle resistance, cardiorespiratory endurance, archery accuracy

I. INTRODUCTION

A lot of people do sports either for hobbies, health, entertainment, or lifestyles. One of the sports they like to do is archery. Archery is preferred by people across ages, such as children, teenagers, and adults. In Indonesia, which its people is predominantly Muslim, archery is also liked by many since it is one of the sports recommended by Prophet Muhammad PBUH. In ancient times, archery was practiced for hunting. However, along with the times, it has become one of the sports being contested. In order to master it, archery requires composure, patience, concentration, and a strong mentality.

Archery is a sport of shooting an arrow through a specific trajectory towards a target from a certain distance. The difference between archery and other sports that require static movement or closed skills, such as shooting, lies in the type of driving force.

In addition to excellent physical condition, an archer must possess good and correct archery basic techniques in order to achieve optimal performance. Harsono (2004:24) stated that there are nine basic techniques for beginner archers to do, which are standing, nocking, extending, drawing, anchoring, tightening, aiming, releasing, and after holding.

Archery is a sport that requires both technical and physical training. Both is equally vital. In Indonesia, the training for archery athletes' physical improvement has not developed even though physical conditions significantly affect athletes' performances. Some research has been conducted to investigate some factors affecting archery accuracy. Pratiwi (2015) used meditation, while Ariyani (2017) used plank exercise to strengthen the arms' muscle resistance. It is believed that muscle resistance is important not only in archery, but also in so many sports. However a more comprehensive training is needed to not only improve the muscle resistance but also cardiorespiratory endurance.

At Selabora FIK UNY, a laboratory school coined to train sports to children under the supervision of Sport Sciences Department of the Yogyakarta State University (Universitas Negeri Yogyakarta/UNY), muscle-strengthening exercises have been practiced by using internal and external weights. However, aerobic circuit training has not been implemented even though both aerobic and anaerobic resistance are necessary to improve performance in archery. There has been little awareness of the effect

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of aerobic circuit training on muscle resistance, cardiorespiratory endurance, and archery accuracy despite of its massive effect on archer's condition.

Griffin (2006:165) suggested that there are two methods of aerobic training, which are interval and continuous aerobic training. Aerobic circuit training can be a good way to enhance the athlete's skill. Aerobic circuit training is a training program developed by Morgan and Anderson in 1953 at University of Leeds, England involving some training posts such as push up, sit up, jumping jacks, burpees, plank, etc., resulted in 12.5% increase of cardiorespiratory endurance (Gotshalk, Berger, and Kraemer, 2004:761).

Many athletes lack awareness of the importance of physical training to increase performance. As a result, they focus only on how to shoot arrows accurately without any regard to their physical abilities, especially muscle resistance and cardiorespiratory endurance. This, however, leads to their low accuracy in archery. Physical abilities required for archery athletes include muscle resistance and cardiorespiratory endurance since in an archery match, an athlete must shoot arrows for 18 series/rounds. They must shoot six arrows in each round and 128 arrows in total. The time it takes to finish all rounds is six to seven hours.

Muscle resistance is the muscle's continuous ability to hold some weight or obstacle, for example leg's muscle resistance during long distance walk (Ahmad, 2007). In archery, arms' muscle resistance is crucial so archers need to have good arms' muscle resistance to keep their technique stable till the end of a match (Heru & Siswantoyo, 2019:71).

Cardiorespiratory endurance is maximal volume of oxygen that can be used in each minute. It is also called as VO_2max. VO_2max is the speed of oxygen use in a maximal aerobic metabolism (Guyton & Hall in Wiarto, 2013:13). Usually VO_2max is counted in a maximal aerobic metabolism during a certain time in a multistage training until the person is exhausted. It is presented per minute or millilitre/minute/kg of one's weight.

Another vital aspect of archery is accuracy. Without good accuracy, supported by a fit physique, archery athletes will not win the match. One point in an archery match can greatly determine the winner. Even though tactics and mentality during a competition greatly affect the results, the no-less important aspects are muscle resistance, cardiorespiratory endurance and archery accuracy. Thus, this study investigated whether aerobic circuit training affect muscle resistance. cardiorespiratory endurance, and archery accuracy.

II. METHOD

This is a quasi-experimental research with one-group pretest-posttest design. This study was conducted on 15th of January until 14th of March 2020 at archery field of the Yogyakarta State University. The population of this study was all the archery athletes of Selabora FIK UNY with some criteria, which were being active for the last three months, having their own equipment, being able to do the 30-meter archery shot, and being 10-13 years of age. There were 11 athletes who met the criteria and those people became the samples of this study.

The variables of this study is the muscle resistance, cardiorespiratory endurance, and archery accuracy. Aerobic circuit training was used as the treatment. The aerobic circuit training involved some training posts such as 15 seconds of jumping jack, 2 minutes of jogging, 15 seconds of plank jack, and 15 seconds of seated two arms rowing.

Data of arms' muscle resistance was collected by asking the respondents to do elevated side plank. while data of cardiorespiratory endurance was collected by conducting multistage fitness test, and data of archery accuracy was collected by doing 36-shot test. There were pretest and posttest conducted for each of the variables.

The data from pretest and posttest regarding the muscle resistance, cardiorespiratory endurance, and archery accuracy were analysed using parametric statistics of normality test with Kolmogorov-Smirnov Test, homogeneity test, and t-test. Normality test was conducted to know whether the data from the variables have a normal distribution or not. The homogeneity test was conducted to know whether the variant of the data is homogenous or not. The t-test was conducted to test the hypotheses of this study.

III. RESULTS AND DISCUSSION

All of the respondents did the tests of the muscle resistance, cardiorespiratory endurance, and archery accuracy. The data was then analysed using normality test, homogeneity test, and t-test.

A. Muscle Resistance, Cardiorespiratory Endurance, and Archery Accuracy of the Archery Athletes

The data on the muscle resistance of the archery athletes of Selabora FIK UNY can be seen in the table below.

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Table 1. Data on Muscle Resistance, Cardiorespiratory Endurance, and Archery Accuracy of the Archery Athletes of Selabora FIK UNY

Respondent	Muscle Resistance		Cardiorespiratory Endurance		Archery Accuracy	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
1	30	44	27.6	31.8	280	306
2	38	54	30.6	34.3	266	295
3	50	67	24.4	29.1	298	310
4	41	61	26.8	28.7	274	308
5	31	57	24	28	284	311
6	21	43	23.2	27.2	306	320
7	50	68	31.4	26.8	315	327
8	54	66	26.4	33.2	265	289
9	57	69	29.5	33.2	310	325
10	60	74	26.4	32.4	315	329
11	35	55	23.6	28.7	250	289
Mean	42.45	59.82	26.71	30.31	287.54	309.91
Median	41	61	26.4	29.10	284	310
Mode	50	43	26.40	28.7	315	289
Std. Deviation	12.61	10.21	2.84	2.71	22.57	14.50

Based on the data, in all of the aspects the posttest scores are higher than the pretest scores. The average score of muscle resistance is increased by 17.37, from 42.45 of pretest score to 59.82 of posttest score. An increase can also be seen on the average score of cardiorespiratory endurance with 3.60, from 26.71 of pretest score to 30.31 of posttest score. Similar occurrence happens on the aspect of archery accuracy average score, with an increase of 22.37 from 287.54 of pretest score to 309.91 of posttest score. The data indicates that the increase of muscle resistance and cardiorespiratory endurance is directly proportional with the increase of archery accuracy.

Muscle resistance in the arms is important, especially in archery, because archery takes place for a long period of time. Therefore, having good muscle resistance in the arms will help stabilize accuracy. Furthermore, aerobic circuit training involves jogging which can slowly increase the endurance of the heart and lungs. Cardiorespiratory endurance allows athletes to play in long-duration matches. Thus, aerobic circuit training improves muscle resistance, cardiorespiratory endurance, and accuracy. It indicates that endurance and accuracy are interrelated.

In order to ensure accuracy, an archery athlete must have muscle resistance in the arms, supported by cardiorespiratory endurance. The results of the current study showed that aerobic circuit training trains all the physical components in the body effectively and the improvement of muscle resistance and cardiorespiratory endurance will help enhance archery accuracy.

B. Normality Test

Data from the samples is considered as having normal distribution if it passes normality test. Below is a table showing data of normality test on the muscle resistance, cardiorespiratory endurance, and archery accuracy.

Table 2. Normality Test on the Data of Muscle Resistance, Cardiorespiratory Endurance, and Archery Accuracy of the Archery Athletes of Selabora FIK UNY

Variable		Z	P	Sig.	Description
Muscle Resistance	Pretest	0.596	0.869	0.05	Normal
	Posttest	0.604	0.859	0.05	Normal
Cardiorespiratory Endurance	Pretest	0.519	0.950	0.05	Normal
	Posttest	0.723	0.673	0.05	Normal
Archery Accuracy	Pretest	0.520	0.950	0.05	Normal
	Posttest	0.410	0.996	0.05	Normal

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The table above shows that the significance value (p) of all variables was greater than 0.05, meaning that the data distributed normally. As all the data had a normal distribution, the parametric statistical analysis was then can be performed.

C. Homogeneity Test

The homogeneity test was conducted since the samples were not categorized into a more detailed one. The data is homogenous if F_{count} is lower than F_{table}. The data of homogeneity test is presented below.

Table 3. Homogeneity Test on the Data of Muscle Resistance, Cardiorespiratory Endurance, and Archery Accuracy of the Archery Athletes of Selabora FIK UNY

Variable	df	Ftable	Fcount	P	Description
Muscle Resistance	1:20	4.35	4.163	0.055	Homogenous
Cardiorespiratory Endurance	1:20	4.35	0.959	0.339	Homogenous
Archery Accuracy	1:20	4.35	0.118	0.735	Homogenous

From the table, it can be seen that the muscle resistance's F_{count} (4.163) is lower than the F_{table} (4.35). Similar result was also visible in the variable of cardiorespiratory endurance in which its F_{count} (0.959) is lower than the F_{table} (4.35). That kind of result was also appeared in the variable of archery accuracy with its F_{count} (0.118) lower than the F_{table} (4.35). The biggest difference was shown in archery accuracy variable. Those results shows that the data is homogenous.

D. T-Test

The t-test was conducted to examine the hypotheses that had been proposed. The hypotheses whether there is an effect of aerobic circuit training on of muscle resistance, cardiorespiratory endurance, and archery accuracy were tested using the paired sample t-test with the significance level of 5%. The results of the t-test can be seen in the table below.

Table 4. T-Test on the Data of Muscle Resistance, Cardiorespiratory Endurance, and Archery Accuracy of the Archery Athletes of Selabora FIK UNY

Variable	df	Ttable	Tcount	P	Sig. 5%
Muscle Resistance	10	2.28	13.124	0.000	0.05
Cardiorespiratory Endurance	10	2.28	3.964	0.003	0.05
Archery Accuracy	10	2.28	7.807	0.000	0.05

The results of the analysis of the muscle resistance of the archery athletes of Selabora FIK UNY showed that the t-count value (13.124) was higher than the t-table value (2.28) and the p value (0.000) was below 0.05, meaning that the t-count value was greater than the t-table value. These results suggest that there is an effect of aerobic circuit training on the muscle resistance of the archery athletes of Selabora FIK UNY. The results of the analysis of the cardiorespiratory endurance of the archery athletes of Selabora FIK UNY showed that the t count value (3.964) was higher than the t-table value (2.28) and the p-value (0.000) was below 0.05, meaning that the t-count value was greater than the t-table value. These results indicate that aerobic circuit training has an influence on the cardiorespiratory endurance of the archery athletes of Selabora FIK UNY. The results of the analysis of the accuracy of the archery athletes of Selabora FIK UNY showed that the t-count value (7.807) was higher than the t-table value (2.28) and the p-value (0.000) was below 0.05, meaning that the t-count value was greater than the t-table value. These results indicate that aerobic circuit training has an influence on the accuracy of the archery athletes of Selabora FIK UNY. All the results showed that the t-count was higher than the t-table, meaning that the hypothesis was accepted and suggesting that there is an effect of aerobic circuit training on muscle resistance, cardiorespiratory endurance, and accuracy among the archery athletes of Selabora FIK UNY.

IV. CONCLUSIONS

Conducted on the archery athletes tf Selabora FIK UNY, the analysis of muscle resistance yielded the results that the t-count value (13.124) was higher than the t-table value (2.28); the analysis of cardiorespiratory endurance yielded the results that the t-count value (3.964) was higher than the t-table value (2.28); and the analysis of the archery accuracy yielded the results that the t-count value (7.807) was higher than the t-table value (2.28). Based on these results, it can be concluded that aerobic circuit training has

an effect on archery athletes' muscle resistance, cardiorespiratory endurance, and archery accuracy. It is important for the archery coach to put more attention on arms' muscle resistance and cardiorespiratory endurance in order to make the athletes have better accuracy. Aerobic circuit training can be a training method to develop those aspects.

Based on the above conclusion, there are some suggestions offered:

1. Archery athletes with poor muscle resistance, cardiorespiratory endurance, and accuracy can make some improvements by performing aerobic circuit training regularly.
2. Coaches should use aerobic circuit training to improve accuracy among archery athletes.
3. Further researchers should conduct research with a wider sample and population, as well as different variables in order to identify other types of training that can affect endurance and accuracy in archery to improve skills among archery athletes.

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