# The effect of circuit training on physical fitness and archery accuracy in novice athletes

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# The effect of circuit training on physical fitness and archery accuracy in novice athletes

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## Abstract

*Introduction*: Physical condition is one of the most important factors in supporting archery. the better the physical condition, the better the concentration to support accuracy in archery. Concentration in archery is the ability to target targets accurately. *Purpose*: The purpose of this study was to determine the effect of circuit training on improving physical fitness and archery accuracy in novice athletes. *Materials and Methods*: Participants were 20 novice athletes, aged 10 to 12 years. Quasi-experimental research design, using two group pretest-posttest design. The method of collecting data on physical fitness uses the Indonesian physical fitness test (IPFT) aged 10-12 years and the accuracy test is by shooting arrows at the target. Data analysis used paired sample t-test, to determine differences in variable groups of men and women. The analysis results showed no difference if the significant value was less than 0.05 ($p<0.05$). Before analyzing the data, a prerequisite test was carried out which included the Shapiro Wilk normality test and the variate homogeneity test using the Levene's test. *Results:* The results showed that there was a significant increase in physical fitness in the male and female groups. Therefore, there was a significant improvement in the accuracy of archery shots in the male and female groups. The study concluded that circuit training is effective for improving physical fitness and archery accuracy in novice athletes.

**Keywords**: archery; arm strength; endurance; physical fitness; training methods

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# INTRODUCTION

Physical condition is one of the important factors in supporting archery, the better the physical condition, the better concentration and more precise in the accuracy of archery. Concentration in archery is the ability to aim accurately at targets. This integration is very important in archery. In this case both eyes will tell you where to release the arrow. One indicator of good physical condition can be seen from the level of physical fitness. In early childhood 10-12 years have begun in physical coaching, therefore the exercise menu needs to be adjusted to one's age [1]. For early childhood training programs that are provided, use the best training load that is with his own weight, because at that age children are still developing. A very common way to assess the state of physical ability is to determine based on diagnostic tests [2,3]. Based on this problem, it is clear that physical condition especially for beginner athletes is very important. So researchers need to improve the components, strength, endurance of arm muscles, endurance of leg muscles, endurance of finger muscles so that it affects the accuracy of archery. According researchers the factors that influence the style or accuracy of aiming are physical conditions, concentration, and technique [4,5]. The right and correct archery technique is very supportive of optimal performance. With the mastery of proper and correct archery techniques will enable the consistency of archery movements both in training and competition. High technical ability is very helpful in directing arrows to the target. Technical advances around bows and arrows and the availability of new materials have increased the accuracy of aiming and being consistent in archery [6,7].

The training program proposed by JP O'Shea, was carried out with 8 training stations [8,9]. Each training station consists of exercises conducted for 45 seconds, and repetition of the exercise between 15-20 times, rest time at one station, before moving to the next station is 1 minute or less. The training circuit program proposed by ELFox is done 6-15 times the training station [10,11]. One exercise at the station is completed in 30 seconds. The circuit completes between 5-20 minutes, with each station resting period being according to Reneker et al., circuit training is an exercise program consisting of several stations and at each station the athlete performs the type of exercise that has been determined, complete when an athlete has completed training at all stations according to the training dose and a predetermined time, circuit training is usually with an individual load approach, because each individual has different abilities that cannot be compared [12]. This fact gives us an effective concept for carrying out circuit training, which allows alternatives for beginners and advanced participants from the main forms physical demand eg general endurance, maximum strength ility, considered when choosing exercises, every person can have a good time [13,14]. Another opinion about circuit training is a form of exercise consisting of a series of sequential exercises, designed to develop physical fitness and skills related to a particular sport. Several studies so far have examined the effects of adaptive physical activity circuit training programmed to improve cardiorespiratory fitness, strength and balance of leg muscles [15,16]. From various opinions about circuit training, it can be concluded that circuit training is a form of training program consisting of a series of sequential training posts, with the aim of training physical conditions. From various theories about circuit training, by looking at age and physical ability considerations, the circuit training program is made for archery beginners aged 10-12 years with a total of 5 training items, or 5 training stations. One training at the station is completed in 30 seconds. One circuit completes between 5-20 minutes, with a rest period for each station is 15-20 seconds. The following form of circuit training for beginners aged 10-12 years.

Physical fitness is defined as the ability to do work efficiently, without causing significant exhaustion [17,18]. In general what is meant by physical fitness is physical fitness, which is the ability of someone to do their daily work efficiently without arising from excessive fatigue so that they can still enjoy their free time. Fitness training involves the use of physical activity to increase the functional capacity and efficiency of the body. Other outocomes that are generally accepted goals of fitness activities are caloric expenditure, weight management, stress management, social interaction, decreased risk of ill health, enhaced self- image, and feeling good [19,20]. There are several terms used for the same purpose as physical fitness, namely physical fitness, physical ability, physical harmony. All that is intended to translate the original term that is *physical fitness.* A person who is said to be fit is characterized by a body that does not contain much fat tissue, strong bones, strong muscles, and has joints that have good flexibility and high respiratory endurance [21,22]. From

some of the opinions above, it can be concluded that physical fitness is the physical ability of a person in carrying out daily activities without causing significant fatigue, so that he can still do other activities. In addition to traditional forms of daily physical exercise, various types of physical exercise are quite interesting and more interesting than regular forms of exercise [23,24].

Accuracy is defined as a person's ability to make voluntary movements for a purpose, for example in the implementation of shootings (archery). Accuracy is about right on target, for example throwing a ball with a predetermined target. Accuracy is the similarity or closeness of the measurement results to the actual figures or data [25,26]. Regarding the target in the sport of archery in question is how one can shoot the aiming arrow or release the arrow aimed at the target specified in archery. So, accuracy is a follow-up movement carried out by the archer in aiming at the target for the purpose of getting the best score. In addition, aiming with your eyes closed and deliberately concentrating on the follow-up phase of aiming will help. close to the backstop, relax, let the bow shoot, and don't move your bow's hand until far after the arrow impacts the target [27]. Accuracy in the sport of archery means accuracy in directing arrows at the target as precisely as possible, with the hope of getting good results. The accuracy of archery is influenced by several things, including physical condition, technique, and concentration. In archery, concentration plays a very important role, because archery is related to accuracy when aiming arrows at the target. So training and concentration in beginner archery athletes need to be trained so that higher concentration, more confidence and improve aiming accuracy.

## METHODS

*Participants*

The participants are novice athletes aged 10 to 12 years who sit in grade four to grade six elementary school. The participants were divided into two groups, namely the male athlete group and the female athlete group. Novice athletes are children who participate in organized archery training consisting of male athletes (n = 10) and female athletes (n = 10).

This type of research is included in quasi-experimental research. According to Neumark, experimental research is basically testing the relationship between cause and effect [28]. This research will examine the effect of circuit training on increasing physical fitness and accuracy of aiming archery in children aged 10-12 years. The design in this research was to use the one -group pretest-posttest design. According to Ma et al. the one group pretest-posttest design is a type of experiment where a single group pretest-posttest design is a type of experiment where a single group has a pre-experimental evaluation, than the influence of the variable, and finally, a post-experimental evaluation, as can be shown in Figure 1 below [29].

Based on Figure 1, O1 shows the pre test (the initial test), P shows the *treatment* (treatment), and O2 shows the post test (final test). However, this research was conducted at Puro Pakualaman Public Elementary School in Yogyakarta City, Indonesia. The research sample was saturated sampling, all of which were sampled as many as 20 students. In conducting the training circuit the instrument of data collection is to classify the level of physical fitness using the norms of Indonesian physical fitness tests (IPFT) Ages 10-12 years. Data collection techniques to measure physical fitness use the Indonesian Physical Fitness test (IPFT) for children aged 10-12 years, including 40 meters running, bending knees, sit ups, upright jumps and 600 meters running. The data collection technique is to measure the accuracy of archery by firing 36 arrows towards the target target with 12 sessions, each session releasing 3 arrows, where each session has a break of about 3 minutes to 5 minutes. The distance used to shoot the arrows was 20 meters. The score on the highest archery target is 10 points and the lowest is 1 point. The norms details of the Indonesian Physical Fitness test (IPFT) for children aged 10-12 years can be contain in Table 1 below.

Tabel 1. Norms of Indonesian physical fitness tests (IPFT) ages 10-12 years

| No | Value | Physical fitness category |
|---|---|---|
| 1 | 22-25 | Very good |
| 2 | 18-21 | Good |
| 3 | 14-17 | Enough |
| 4 | 10-13 | Less |
| 5 | 5 - 9 | Very less |

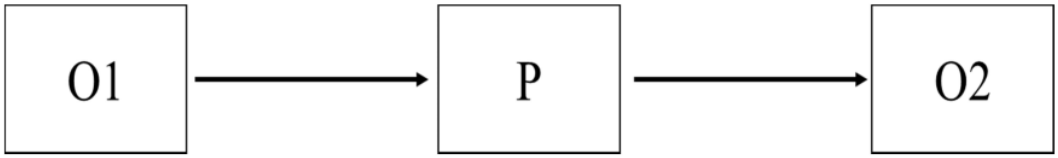


Figure 1. Design of experiment test

*Statistical analysis*

The analysis techniques used in this research are as follows Shapiro Wilk normality test and Homogeneity test using Levene's test with F test. Test data conducted in this research are paired sample t-test with the aim of processing interpretation to compare the average of two variables from one sample group by calculating the difference between two variables in each cases of relevance [30]. To find out whether there are differences in the variables between pretest and posttest in the experimental group. Analysis shows there is a difference if the value is significantly less than 0.05 ($p < 0.05$). If using a SPSS 22 computer program with a significant level of 5% or 0.05.

## RESULTS

The results of physical fitness tests (IPFT) during the pre-test included that the level of physical fitness; (1) 40% enough categories, (2) 45% less categories, (3) 15 very less categories, can be seen in the following Table 2. The results of physical fitness tests (IPFT) during the posttest included that the level of physical fitness, 15% very good categories, 55% good categories, 30% enough categories, can be seen in the following Table 3. Normality test results for physical fitness variable values and archery scores in the male group for pre-test showed that the physical fitness values were normally distributed ($p=0.799$), archery scores were normally distributed ($p=0.308$).

Table 2. Physical fitness test results during the pre test

| No | Physical fitness category | Frequency | Percentage |
|---|---|---|---|
| 1 | Very good | 0 | 0 |
| 2 | Good | 0 | 0 |
| 3 | Enough | 8 | 40% |
| 4 | Less | 9 | 45% |
| 5 | Very less | 3 | 15% |
| | Total | 20 | 100% |

Table 3 . Physical fitness test results during the post test

| No | Physical fitness category | Frequency | Percentage |
|---|---|---|---|
| 1 | Very good | 3 | 15% |
| 2 | Good | 11 | 55% |
| 3 | Enough | 6 | 30% |
| 4 | Less | 0 | 0 |
| 5 | Very less | 0 | 0 |
| | Total | 20 | 100% |

The post-test showed that the physical fitness values were normally distributed (p=0.494) and archery scores were normally distributed (p=0.815). While the normality test results on the variable physical fitness values and archery scores in the female group for pre-test showed that the physical fitness values were normally distributed (p=0.399), archery scores were normally distributed (p=0.453). Midlle tests showed that the physical fitness values were normally distributed (p=0.813) and the archery scores were normally distributed (p=0.522). The post test results give results that the physical fitness value is normally distributed (p=0.838) and the archery score is normally distributed (p=0.705). Concluded that the data normally distributed can be seen in the following Table 4.

Homogeneity test results for the value of physical fitness variables and archery scores in the group of male and female for the pre-test showed that the physical fitness values of the variance were homogeneous (p=0.950), archery scores for the variance were homogeneous (p=0.507). Midlle test shows that the physical fitness value of the variance is homogeneous (p=0.425) and the archery score of the variance is homogeneous (p=0.154). Post-test showed that the physical fitness value of the variance was homogeneous (p=0.769) and the archery score of the variance was homogeneous (p=0.831) concluded that homogeneous data can be seen in the following Table 5.

Table 4 . Normality test results physical fitness scores and archery scores

| Group | Variable | Pre test | Middle test | Post test |
|---|---|---|---|---|
| Male | Physical Fitness | 0.799 | 0.835 | 0.494 |
| | Archery Score | 0.308 | 0.101 | 0.815 |
| Female | Physical Fitness | 0.399 | 0.813 | 0.838 |
| | Archery Score | 0.453 | 0.522 | 0.705 |

Table 5 . Homogeneity test results physical fitness scores and archery scores

| Group | Variable | F test | p |
|---|---|---|---|
| Pre test | Physical Fitness | 0.004 | 0.950 |
| | Archery Score | 0.459 | 0.507 |
| Middle test | Physical Fitness | 0.667 | 0.425 |
| | Archery Score | 2.211 | 0.154 |
| Post test | Physical Fitness | 0.089 | 0.769 |
| | Archery Score | 0.047 | 0.831 |

p - statistical significance

Table 6 . Paired sample test results t-test variable IPFT and male group archery scores

| Variable | Type of test | Mean | t-test | p |
|---|---|---|---|---|
| IPFT value | Pre test | 11.80 | -4.823 | 0.001 |
| | Middle test | 16.70 | | |
| | Middle test | 16.70 | -2.045 | 0.071 |
| | Post test | 18.80 | | |
| | Pre test | 11.80 | -6.641 | 0.000 |
| | Post test | 18.80 | | |
| Archery Score | Pre test | 145.60 | -3.301 | 0.009 |
| | Middle test | 171.80 | | |
| | Middle test | 171.80 | -4.403 | 0.002 |
| | Post test | 204.70 | | |
| | Pre test | 145.60 | -8,245 | 0.009 |
| | Post test | 204.70 | | |

p - statistical significance

Table 7 . Paired sample test results t-test variable IPFT value and female's group archery score

| Variable | Type of test | Mean | t test | p |
|---|---|---|---|---|
| IPFT value | Pretest | 13.20 | -3,656 | 0.005 |
| | Middletest | 16.70 | | |
| | Middletest | 16.70 | -3,596 | 0.006 |
| | Posttest | 19.80 | | |
| | Pretest | 13,20 | -13,229 | 0.000 |
| | Posttest | 19.80 | | |
| Archery Score | Pretest | 155.30 | -5,608 | 0.000 |
| | Middletest | 187.70 | | |
| | Middletest | 187.70 | -4,231 | 0.002 |
| | Posttest | 214.50 | | |
| | Pretest | 155.30 | -5,591 | 0.000 |
| | Posttest | 214.50 | | |

p - statistical significance

Based on the results of the t test on circuit training is effective against increasing physical fitness and accuracy of aiming archery at male groups. The results of the analysis of the increase in physical fitness showed that t count 6.647> t table 2.262 with a significant level of p=0.000<0.05. It turns out that the price of t arithmetic is at the acceptance of $H_a$, because t arithmetic is greater than t table. Thus the null hypothesis ($H_o$) is not accepted and $H_a$ which states there is a difference in the level of physical fitness between pretest and posttest is accepted. While the results of an analysis of increasing accuracy in aiming archery that t count 8.245> t table 2.262 with a significant level of p=0.009<0.05. It turns out that the price of t arithmetic is at the acceptance of $H_a$, because t arithmetic is greater than t table. Thus the null hypothesis ($H_o$) is not accepted and $H_a$ which states there is a difference in the level of accuracy of aiming archery between pretest and posttest is accepted. Thus, it can be concluded that circuit training is effective against increasing physical fitness and accuracy of aiming archery at the male group can be seen in Table 6.

Based on the results of a series of t-test exercises effective in improving physical fitness and accuracy of shooting archery in the women's group. The results of the analysis of the increase in physical fitness obtained t count 13.292> t table 2.262 with a significant level of p = 0.000 <0.05. It turns out that the price of t count is accepted by Ha, because t count is greater than t table. Thus the null hypothesis (Ho) is not accepted and Ha which states that there is a difference in the level of physical fitness between the pretest and posttest is accepted. While the results of the analysis of the increase in aiming accuracy that t count 5,591> t table 2.262 with a significant level of p = 0.000 <0.05. It turns out that the price of t count is accepted by Ha, because t count is greater than t table. Thus the null hypothesis (Ho) is not accepted and Ha which states that there is a difference in the accuracy of archery shots between the pretest and posttest is accepted. Thus, it can be concluded that circuit training is effective in improving physical fitness and accuracy of shooting archery in the female group. The components of circuit training that have a big influence on archery accuracy are hanging exercises by bending the knees of the feet, with hanging exercises by bending the knees for a few seconds, the hand muscles become stronger because the hands can hold the weight of the body. Thus, it can be explained that when the hand muscles are stronger, when the hand is about to release the arrow the hand is not prone to fatigue. The following can be seen in Table 7.

## DISCUSSION

Based on the results of the t test on circuit training is effective against increasing physical fitness in the group of male. The results of the analysis of increased physical fitness showed a significant level of p=0.000<0.05. Thus it states there is a significant difference between pretest and posttest, and it is concluded that circuit training is effective in increasing physical fitness in the male group. While the

results of the analysis of increasing accuracy in aiming archery showed a significant level of p=0.009<0.05. Thus it states there is a significant difference in the level of accuracy of archery between the pretest and posttest, and it is concluded that circuit training is effective in increasing the accuracy of aiming archery in the group of male. Based on the results of the t test on circuit training is effective against increasing physical fitness in a group of female. The results of the analysis of increased physical fitness showed a significant level of p=0.000< 0.05. Thus it states there is a significant difference between pretest and posttest, and it is concluded that circuit training is effective in increasing physical fitness in a group of female. While the results of the analysis of increasing accuracy in aiming archery showed a significant level of p=0.000<0.05. Thus it states there is a significant difference in the level of accuracy of archery between the pretest and posttest, and it is concluded that circuit training is effective in increasing the accuracy of aiming archery in the group of female.

The results show that, circuit training can improve physical fitness in groups of male and female to have a significant effect on improving physical fitness and improve accuracy in aiming archery. This is because there are several factors that influence it, including the form of training requested by athletes, various forms of enjoyable training, seriousness in doing the exercise, adequate training time, training program The circuits provided cover all physical fitness components, controlled circuit training. According to the results of survey the level of physical fitness of students in Indonesia is still in the bad category [31]. However, circuit strength training shows significant interaction effects and effect sizes that are relevant for a 12 week training period [32,33]. Strength training must be planned and systematic work during the micro, mezo, and macro cycles over the years of the training plan [34]. The high level of physical fitness of an individual athlete is one of the main factors in achieving sports success [35]. While there was a significant effect on increasing the accuracy of aiming archery in the male group, this also happened in the female group.

For this reason, the form of circuit training programs provided tends to lead to forms of training aimed at increasing muscle fitness and endurance. Other factors that make archery targets with accuracy in male and female groups increase because researchers provide training in between visualization exercises, hoping to help athletes concentrate, because concentration is important in archery accuracy besides physical conditions. From the discussion above, proper circuit training for sports increases muscular endurance, which has been proven by how accurate archery is. From the results of the research and discussion above, circuit training has a significant effect on increasing physical fitness in male and female groups. this is supported by Daniel's statement that circuit training is effective in increasing and maintaining muscle and cardiovascular endurance among school children [36]. Experienced archers show better accuracy and at the same time less heart rate compared to inexperienced archers [37]. This can help physical education teachers design programs that allow students to maintain their muscular and cardiovascular endurance levels. Physical fitness variables have a significant effect on archery productive performance [38]. Standard measures of fitness and ability such as hand grip, vertical jump, standing long jump, static balance, upper muscle strength and muscle strength, these measurements aim to categorize high and low potential archers [39]. That simple field physical fitness test and simple devices such as polar heart rate meter may have an advantage in selecting a good shooter [40]. Based on available research on the importance of physical fitness parameters in target shooting discipline [41].

## CONCLUSIONS

Based on the analysis conducted in this research, it can be concluded that: circuit training has a partially significant effect on physical fitness and accuracy of archery aiming at beginner athletes. Furthermore, for further research, the researcher provides suggestions for expanding further in terms of variables such as concentration levels, anxiety levels. Because there are various variables other than circuit training that can affect athlete fitness in improving archery accuracy. For trainers, it is expected to be an evaluation for the future in taking steps, taking into account that by conducting circuit training at a maximum ability of 70-80% can improve archery accuracy, and circuit training methods can be used to improve the physical condition of novice athletes.

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