The effect of bow training on increasing upper limb muscles in adolescent archery athletes

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Abstract

Achievement in the sport of archery is determined based on the sum of the scores of arrows shot by an athlete hitting the target. This sport requires full concentration and good muscle endurance to support performance in the competition area. Muscle endurance is also influenced by muscle strength, which can be seen from an archery athlete's composition of muscle mass. This research aims to determine the influence of bow training on upper arm muscle hypertrophy. This research uses a pre-experimental method with a One-Group Pretest-Posttest approach. The test instrument uses a Seca Body Analyzer and a scale used to measure muscle hypertrophy with a kilogram measuring scale. Participants in this research were 17 archery athletes from Malang City. The results of the research show that based on data analysis, a *t*-value *p*-value < 0.05 can be obtained. These results indicate that there is an effect of bow training on muscle mass. Therefore, it can be interpreted that bow training has an effect on arm muscle hypertrophy in adolescent archery athletes in the city of Malang. Based on the results of the research that has been carried out, it can be concluded that there is an influence of bow training on upper arm muscle hypertrophy in adolescent archery athletes in Malang City. This can be used as a guideline in creating a training program during competition preparation for archery athletes.

Keywords

Contribution

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Introduction

Achievement in archery is determined based on the total score of arrows shot by an athlete hitting the target. Targeting performance is influenced by various factors including environmental conditions, fatigue, and the athlete's technique, in addition to the influence of materials that determine bow and arrow behaviour.[1] The placement of the fired arrows on the target board is thought to imply important information for assessing targeting performance, which is displayed in response to such complex textures.

Achievement in archery is defined as the ability to shoot arrows at a certain target with accuracy.[2] Thus, archery is a sport that requires fineness of movement control, and each phase of the shot—holding the bow, drawing, full draw, aiming, release and follow-up must be a stable sequence of movements.[3] Such conditions must be supported by excellent physical condition.

Many factors can interfere with an archer's ability to practice consistently during the general preparation period. When the competition or race season arrives, they take their bow and realize that they have lost some power. Strength is formed by strong muscle tissue as a result of training.[4] An archery athlete is required to have good muscle strength and endurance to support stability and concentration when aiming at the target.

Bow training is an exercise carried out by bow archers by pulling the string without using an arrow, holding it for a few seconds, and doing it repeatedly.[5] Bow training is a unique tool that can help archers gain better accuracy, improve their form and increase their strength and stamina. Bow training is the perfect tool for archers of all ages and experience levels, from beginners to seasoned professionals. Therefore, it allows continuous use of the upper arm muscles to change the composition of muscle tissue in the body. Usually, the impact produced by bow training is muscle hypertrophy or enlargement of muscle tissue, which is characterized by an increase in muscle fibers.

Previous bow training methods indicated only that there was an influence on archery accuracy.[6] Other research also found better archery performance after applying bow training methods to novice athletes.[7] However, a review regarding the effects of bow training on increasing muscle mass has not been carried out previously. Analysis of physiological aspects specifically after training has not been found in previous studies. The effects of training certainly impact not only performance but also human physiology, including muscle mass.

This research aims to determine the effect of bow training on arm muscle mass by reviewing the presence of arm muscle hypertrophy in adolescent archery athletes.

Methods

Participants

The research used is a type of quantitative research with a pre-experimental design using a One Group Pretest-Posttest Design research design, so that it can be measured more accurately, before and after treatment. The sample in the study consisted entirely of novice archery athletes from the archery training centre in Malang City, East Java, Indonesia, consisting of 17 athletes (7 males and 10 females). The average age of athletes was (16.4 ± 1.1 years) for males and (16.7 ± 0.8 years) for females. The athletes used in this study predominantly used their right arm to draw the bow. The selected participants are teenage athletes who still have no experience in national competitions. Selected athletes have agreed to participate in this study and have provided written informed consent.

Procedure

Bow training treatment was carried out by all research participants (there was no control group) with training taking place over the course of 8 weeks with a training frequency of three days a week. The training was led by archery practitioners accompanied by a research team. Bow training is done by pulling the bow and holding it while aiming at the target for 10–15 seconds. The bow training program consists of 3 types of core training, namely by:

1. Using a modified tool made from fibre material that has been adapted to resemble a bow with a weight of approximately 10 kg (10 reps × 2 sets with a rest of 30–60 seconds; increase by one set every 1 week).
2. Using resistance band with medium rubber weight (15 reps × 2 sets with rest 30–60 seconds; increase by one set every 2 weeks).
3. Using archery equipment according to the competition number in this case is a standard bow (20 reps × 2 sets with rest 30–60 seconds; increase by one set every 3 weeks).

During training, athletes are recommended to perform only those exercises which do not use gym machines, such as push-ups and pull-ups. Once a week

an internal competition is held to hone the athletes' targeting skills. Monitoring of the increase in exercise intensity was carried out after 3 days of exercise. Loading is carried out in stages from the training cycle or program that has been prepared. There are no dietary arrangements and participants are not in quarantine. Arm muscle mass was measured twice, namely before and after the training program took place. Muscle mass measurements were carried out using the SECA Body Analyzer mBCA 525, which has been declared valid and reliable.

Statistical analysis

The normality test is used to determine the data generated from the test to determine hypothesis testing steps. To test the normality of the data, the Shapiro-Wilk test was used. The paired sample t-test with a significance value of $p < 0.05$ was used to determine the effect of the training program. Data analysis uses the IBM SPSS version 26 application to obtain precise and accurate data analysis.

Results

The results of this study indicate that muscle mass increased after participants were given an exercise program according to the planned schedule. They have also shown that muscle mass increased on both the left and right arms of the participants. Data from the following test results can be seen in Table 1.

Table 1. Measurement test results using SECA Body Analyzer

Gender	Pre-test (kg)	Post-test (kg)	Significance
Left arm			
Men	1.19 ± 0.3	1.24 ± 0.3	0.003[*]
Women	0.87 ± 0.2	0.94 ± 0.2	0.001[*]
Right arm			
Men	1.29 ± 0.3	1.33 ± 0.3	0.007[*]
Women	0.98 ± 0.2	1.12 ± 0.2	0.006[*]

Note: [*]Significant p-value < 0.05.

Based on Table 1, the results of the statistical test analysis of pre-test and post-test data on muscle mass measurement tests for 17 athletes are presented. The average increase in muscle mass of the left arm in the male group was 4.2%, while in the female group it was 8.04%. The average increase in muscle mass of the

right arm in the male group was 3.1%, while in the female group, it was 9.2%. These results indicate a small effect of bow training on changes in muscle mass, specifically on its increase.

Before training, it was discovered that the average muscle mass in the left arm was smaller than in the right arm. After being given training, muscle mass in both the right and left arms increased in both male and female athletes. However, there is still a difference in muscle mass. The right arm tends to have slightly greater muscle mass than the left arm. This is because the right arm has the dominant muscle group during training.

Discussion

The arm is the most important part part of the body in the sport of archery. To aim well, an archery athlete must be supported by good physical condition, especially of the arm. To get the best score in archery an athlete must be able to hold the arrow calmly and pull the bowstring firmly. The physique required of archery athletes includes arm muscle endurance, because in an archery competition athletes have to shoot 24 series of 6 arrows for a total of 144 arrows shot. This can take a long time, usually around 6–7 hours.[8] An archer's achievement is being able to collect the highest point at a distance of 90 m, 70 m, 50 m and 30 m, by shooting arrows divided into 4 varying distances and at each distance the athlete will shoot 36 arrows.[9]

At the end of the aiming phase, an archer must simultaneously take aim on his own, control the final draw, and hold the bow calmly.[10,11] Similar to the Bow Training exercise, this exercise requires the athlete to pull the bowstring strongly and train their sights on the target. This exercise uses elements of strength and if done repeatedly can cause chronic effects, namely muscle hypertrophy. Three main factors are emphasized in conventional hypertrophy models: mechanical strain, metabolic stress, and muscle damage.[12] The increase in the number of actin and myosin filaments in muscle fibres produced by Bow Training, causes parts of the muscle fibres to enlarge, and muscle hypertrophy occurs.[13]

Gender differences in the relationship of muscle and bone growth are generally not apparent in early childhood, and studies show little or no differences in the relationship of muscle to bone area. However, gender-variant patterns emerge during adolescence, reflecting different musculoskeletal effects of testosterone and estrogen in men and women.[14] In men, bone and muscle changes during puberty are dominated by increases in testosterone and IGF-1 levels, resulting in increases in

muscle mass and strength. The combination of higher deformation forces and higher bending moments due to longitudinal growth results in a bone growth pattern dominated by periosteal apposition. Thus, in men, muscle and bone growth are more parallel in nature and the peak values of cortical area and muscle cross-sectional area tend to coincide within half a year in men. In girls, with lower testosterone levels, and higher estrogen levels, bone mass, but not total cross-sectional area, tends to increase more rapidly in relation to muscle area.

Bow Training is an exercise that does not require a large field and can be done anywhere, using a bow system to practice. To train muscle strength, bow training is also more effective, especially for upper arm muscle strength. This training is more efficient than usual archery training because bow training only takes one hour, but the time spent performing physical exercise is the same as during a typical archery training session, which lasts two hours. Other research also says that if bow training is combined with normal archery training, it increases muscle endurance and stability.[15] Apart from that, bow training also has a slight weakness, namely that it cannot train the release feeling of releasing the arrow, and it cannot provide additional physical training, such as walking when pulling the arrow at the target pad.

The importance of arm muscle endurance and archery accuracy, especially in the sport of archery, is because archery is done for quite a long time, therefore having good arm muscle endurance can help with stability during archery, which will result in higher archery accuracy and getting perfect points.[16] Bow training exercises greatly affect endurance of the arm muscles. It is one of the basic archery training techniques because it builds arm muscle endurance through pulling the bow and holding it for several seconds to several minutes.[17] In addition, when archers draw the bow and aim at the target, they try to maintain postural stability at the highest possible level by keeping the arm and body posture still.[18]

Important limitations of the current study can be found. Athletes' performance was analyzed only for a limited sample size. Therefore, there are limitations to generalizing the performance characteristics of athletes across the training period. In future research, it is necessary to analyze athletes' training performance to increase muscle mass with a large number of various archery athletes from all class levels.

Conclusion

In conclusion, this study highlights the impact of bow training on the arm muscle mass of adolescent archery athletes. The results obtained were the influence of training on signs of muscle hypertrophy in athletes. This exercise can be included by practitioners in the field of archery for preparing training, especially for teenage athletes. Apart from that, this exercise can be used as a guide in creating a training program during competition preparation. It is recommended that future studies investigate the effects of bow training on a broader population as well as those above levels in the current population.

Acknowledgments

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