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THE INFLUENCE OF ARM LENGTH, VO2 MAX AND CORE STABILITY ON ARROW SKILLS

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Abstract The purpose of this study was to determine the relationship between arm length, VO2 Max and Core stability on archery skills. A total of 24 athletes of KOP Archery Fortius, State University of Jakarta who became the research subjects. Measurement of research results using anthropometric measurement instruments of arm length, running multistage fitness test (Balke test) , plank and shooting 3 arrows for 10 series and 2 sessions with the highest total score of 600 with a distance of 18 meters. Analysis of research data using path analysis technique. Based on the results of this study, it was explained that the seven research hypotheses were accepted. H1: There is a direct effect of arm length (X1) on archery skills (Y). H2: There is a direct effect of VO2 Max (X2) on archery skills (Y). H3: There is a direct effect of Core stability (X3) on archery skills (Y). H4: There is a direct effect of arm length (X1) on Core stability (X3). H5: There is a direct effect of VO2 Max (X2) on Core stability (X3). H6: There is a direct effect of arm length (X1) on archery skills (Y) through Core stability (X3). H7: There is a direct effect of VO2 Max (X2) on archery skills (Y) through Core stability (X3).

Keywords: archery; arm length; VO2max; core stability

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INTRODUCTION

Archery at first glance is indeed a simple and easy sport, because the movement of archery only draws, aims and releases arrows towards the target and this is done repeatedly. But actually archery has basic techniques that must be mastered first. An archer must master the basic techniques of archery properly and correctly in order to achieve maximum performance. Mastery of good and correct archery techniques will allow an archer to gain consistency in archery.

The fact is that many of the archers are not able to achieve maximum scores in an extended session of the match. This can be caused by many factors. It could be due to physical, technical or psychological factors. Therefore, to address this problem, it is necessary to find a solution.

Various disciplines and technological advances that have been owned can be used as media and means to assist efforts to improve movement skills which ultimately leads to optimal results and optimal sports achievements.

Archery itself has long been known in Indonesia. Starting from the establishment of an archery

organization in Indonesia which was formed on July 12, 1953 in DI Yogyakarta on the initiative of Sri Paku Alam VIII, then Indonesia officially became a member of FITA (Federation Internationale de Tir A L'arc) in 1959 at the congress in Oslo, Norway (Saddle & Oktafiranda, 2017).

A common problem in archery is when one learns archery and masters basic skills. However, when entering a competition, the skills learned are often lost. The ambition to change the technique that has been learned to get a good score is to make sure that the arrows are on target. This is far from what was expected in the end.

It turns out that this does not only happen to those who are learning archery. Based on data obtained by PPLM DKI Jakarta athletes in 2017 and 2018, the average score obtained during the match was reduced compared to training. In addition, the average score achieved by DKI Jakarta Pelatda Athletes at the 2018 National Championship has decreased compared to when completing the training camp. From some of the incidents above, it can be seen that the average shooter experienced a decrease in his score during a match even though his training

was very intense. Therefore, this research was conducted with the aim of

providing treatment in the form of psychological exercises, namely imagery training and relaxation.

There are still many archery activists who think that archery is a sport that uses an aerobic energy system. Then the latest research began to be carried out to find answers whether archery is a sport that uses an aerobic or anaerobic energy system?

there are four factors that affect the performance of an archer, namely physical, technical, mental and strategic. Of the four factors, the mental factor with the greatest influence is 51.9%, followed by techniques that affect the physical 32.8%, then the strategy which each has an effect, the physical 7.8% and the strategy 7.5% (Jang Ho, 2016).

In another study conducted in Korea, of the 3 factors studied, namely mental, technical and physical. The mental factor is still the most influential factor on the archer's performance compared to the other two factors. Mental factors have an influence of 47.9%. Furthermore, the technical factor that has an influence of 34.4%. And finally, the physical factor that has an effect is 17.7% (Han-Byu et al., 2015).

In the sport of archery, it is known that there are 3 types of bows that are currently widely used. There are recurve, compound and standard bows. The three arcs have their own differences and characteristics (Parena et al., 2017) (Fajri & Prasetyo, 2015).

One of the efforts to improve sports performance for athletes is with appropriate and proportional body

Archery Events:		
Men`s Events	*Women`s Events*	
Individual (70 meters)	Individual (70 meters)	
Team (three archers, 70 meters)	Team (three archers, 70 meters)	
Archery:		
Energy Systems*	Anaerobic, ATP – CP	95%
	Anaerobic, Glycolysis	5%
	Aerobic	0%
Pre – Competition Carb Loading		No
Average Calories Burned per One Hour**		230
Endurance Diet Required		No
Risk of Muscle Breakdown (Rhabdomyolysis)***		Low
Risk of Sports Injuries		Low
Benefits from Creatine****		Moderate
Fitness Demands	Agility	No
	Endurance	+
	Explosive Power	Yes
	Speed	No

Figure 1. Archery Sports Energy System
Source: https://www.caasn.com/

From the picture above, it can be seen that the assumption that archery is included in aerobic exercise is wrong. The largest energy system at work in archery is the anaerobic system which uses phosphocreatine as 95% of its primary energy source. And 5% is aerobic using glycolysis as the main energy source (Nutrition, nd).

According to research conducted at the Korea Institute of Sports Science,

conditions. Anthropometry is used as a benchmark that can support sports performance for example height, weight, sitting height, leg length, body

fat thickness, arm length, body circumference and others (Sidik et al., 2019).

Arm length is one of the limbs included in anthropometric measurements, namely one of the upper limbs consisting of the upper arm, forearm, hand and fingers (Putri et al., 2018).

According to the anatomy team of FIK UNY, arm length is the body part along the upper and lower arms measured from the acrominal point to the styloid point. The styloid point is the tip of the radius styloid process (Saddle et al., 2021).

So from the above opinion it can be concluded that the arm length is the arm measured from the acromion to the tip of the middle finger measured in the anatomical position. Based on the description, the arm length referred to in this study is the length of the arm measured from the tip of the finger to the base of the shoulder.

The length of the arm for the archer will later affect the length of the draw (draw length). Draw length is the

length of the draw of an archer. The speed of the arrow is one of the factors that determine the level of accuracy of the arrow in aiming its target. The higher the arrow speed, the smaller the angle of the arrow's parabolic trajectory. This will minimize the barrier from the influence of the wind that can deflect the arrow's direction (Ryanto, 2017)

Oxygen is the most important part in the respiratory process. When oxygen is inhaled, the lungs will absorb it and convert it into energy called adenosine triphosphate (ATP). ATP activates body cells and helps release carbon dioxide (CO2) from the respiratory process (Junaidi, 2020).

The higher the VO2 Max. the more oxygen the body can consume and the more effectively the body uses oxygen to produce the maximum amount of ATP energy. This means that the body can work better in aerobic fitness activities that require a lot of oxygen intake, such as running, swimming, and various other types of cardio exercise.

Several aspects of aerobic endurance are very important in determining the endurance of an athlete. These factors include the athlete's aerobic performance, lactate threshold,

exercise, and type of muscle fiber (Lubis, 2013). Each element can be significantly improved with the right training methods. To develop aerobic

endurance according to an exercise program, coaches and athletes need to understand the physiological responses associated with endurance performance.

Core stability was first introduced in 1940-1950 by two physiotherapists, Henry and Florence Kendall. This core stability was developed from the idea of "Neutral pelvis". They originally said the superficial muscle groups are involved in maintaining alignment and the " neutral spine " that surrounds the spine and abdomen. The muscles in question include the erector spinae muscles, hamstring muscles, abdominal muscles, and hip flexor muscles (Saputra, 2019) .

Core stability is the key to motor control to initiate body movements as needed during activity. Core stability is essential for balancing the spine, pelvis and kinetic chain. In sports medicine, it is used in core stability exercises to improve performance, prevent injury, and exercise therapy to treat back pain (Akuthota et al., 2008).

Core stability allows one to maintain a rigid midsection without other forces such as gravity affecting the desired movement. Some of the benefits associated with core stability training include:

a. Better posture
b. Fewer injuries
c. Better agility and increased ability to change direction
d. Improved balance and coordination
e. Increased power and speed (lawrence, 2011).

Balance is influenced by the performance of the deep muscles that maintain postural stability, so that core stability exercises that train and strengthen the work of the deep muscles can be combined with other exercises to improve balance (Pristianto et al., 2016)

In archery, the dominant body components used are the muscles of the vertebrae, upper extremities, core muscles, lower extremities, and joints associated with these muscle groups (Dewi & Palgunadi, 2021). In fact, core stability is described as a product of motor control and muscle capacity of the lumbo-pelvic-hip complex, which in musculoskeletal terms consists of the spine, hip and hip joints, and the proximal lower extremities in addition to all associated muscles. All of these parts are parts that support every

movement in archery, especially maintaining body balance. Where as a prospective archery athlete, body balance, especially static balance, is

needed to maintain stability during the set-up position and draw the bow to aim at the target (Dewi & Palgunadi, 2021) .

Archery is a sport of targeting accuracy, because the ultimate goal of archery is to shoot arrows to the target face as precisely as possible, so that one of the basic factors needed in archery movements is consistency which must be done continuously during practice and throughout the course of the exercise. competition (Akbar & Nurhayati, 2018)

To be able to have archery movement skills, an archer must master the techniques in archery. Efforts in mastering proper and correct archery techniques cannot be separated from the mechanics of motion in archery (Vanagosi, 2015).

Correct archery technique closely related to anatomy and kinematics. The movement mechanism allows the athlete to create incredible consistency. Movement mechanism Archery consists of two axes of motion namely Wave I and Wave II, with Axis I aligning the shoulder posture and

archer posture. Axis II represents the shoulder stance and arm stance arc in a straight line (Ahmad et al., 2014).

Archers rely on two sources of information to correct performance errors. They analyzed where their arrows landed in relation to the target at which their shot was directed. That is, they analyze the results of their performance. They also check their technique, their actual positioning and movement, by evaluating the nuances of their shot or watching videos of their technique.

The technology available today makes even this evaluation fun! Every archer would probably take advantage of the opportunity to work with a good coach. Even archers lucky enough to have a trainer, though, spend hours shooting without a trainer while training, competing, or hunting.

The sooner the error can be corrected, the better. Keep in mind that most types of archery involve repeated shooting. Archers who can quickly adjust their technique to deal with mistakes will score more consistently than those who cannot (Haywood & Lewis, 2014).

METHODS

Based on the background, research objectives, and theoretical studies, the research method used in this study is a quantitative approach, survey method with correlational study.

Research variables are everything that is used as material for

researchers to study, so that from the information available, researchers obtain conclusions. The variables in this study, in the form of:

1. Independent Variable

The independent variable is a variable that affects other variables or which researchers are looking for. The independent variables in the research are:

X1: Arm Length
X2: VO2 Max
X3: Core Stability

2. Bound Variable

The dependent variable is all forms of events or symptoms that occur as a result of the independent variable. The dependent variable in this study is the result of shooting from the sport of archery.

Researchers used path analysis techniques to examine the direct and indirect effects of arm length, VO2 Max and core stability factors on archery skills.

Below is a picture of the constellation of relationships between independent and dependent variables in this study.

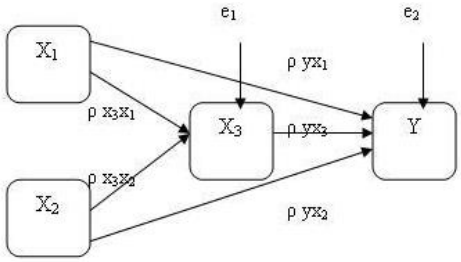

Figure 2. Constellation of influence between X1, X2, X3, and Y

This study involved three independent variables, namely arm length (X1), VO2 Max (X2) and Core Stability (X3), as well as one of the dependent variables, namely the results of the archery scoring test (Y). To avoid over-interpreting this research, the variables in this study will be explained in detail.

Scoring test is the score of the arrows fired at the target. In this study using a distance of 18 meters with a standard bow for 2 sessions. Each session consists of 10 series and each series as many as 3 arrows. The archery skill test instrument in this study was the scoring test at a distance of 18 meters.

Arm length is the anatomical distance of the arm measured from the acrominal point to the tip of the middle finger. The arm length test instrument in this study was the arm length anthropometer test.

VO2 Max is the maximum level of oxygen that is useful for the body

during activity/exercise. The instrument used in this research is to use a multistage test or the Multistage Fitness Test or commonly known as the bleep test.

Core Stability is the core muscle group that surrounds the spine and abdomen and controls the position and movement of the core to create optimal movement along the way. The instrument used in this research is the plank test.

RESULTS AND DISCUSSION

The results of this descriptive study contained research on 23 archery athletes which included archery skills (Y), arm length (X1), VO2Max (X2), and core stability (X3). Summary of data processed with descriptive statistics in the form of mean, median, mode, standard deviation, minimum, maximum, and range are presented in the following table.

Direct Effect of Arm Length (X1) on Archery Skills (Y)

	Arm Length	VO2 Max	Core Stability	Archery Skills
mean	73.96	46.46	269.30	555.13
median	74.00	46.50	279.00	555.00
Mode	76.00	47.60	286.00	531.00
Std. Deviation	2.25	2.88	25.68	26.01
Range	10.00	11.90	81.00	99.00
Minimum	68.00	39,50	221.00	495.00
Maximum	78.00	51.40	302.00	594.00

Table 1. Table of Research Variables

Direct Effect of Arm Length (X1) on Archery Skills (Y)

Hypothesis 1 is that there is a direct effect of arm length (X1) on archery skills (Y), with the following test criteria.

H0: x1y = 0

H1: x1y 0.

Based on the calculation results, the path coefficient is 0.253 with a p value of 0.017 <0.05, so reject H0 and accept H1 so that there is a direct effect of arm length on archery skills. The contribution value of arm length is $(0.253)^2$ x 100% = 6.4%.

Direct Effect of VO2Max (X2) on Archery Skills (Y)

Hypothesis 2 is that there is a direct effect of VO2Max (X2) on Archery Skills (Y), with the following test criteria.

H0: x2y = 0

H1: x2y 0

Based on the calculation results, the path coefficient is 0.520 with a p value of 0.000 <0.05, so reject H0 and accept H1 so that there is a direct effect of VO2Max on archery skills. The contribution value of VO2Max is $(0.520)^2$ x 100% = 27.04%.

Direct Effect of Core Stability (X3) on Archery Skills (Y)

Hypothesis 3 is that there is a direct effect of core stability (X3) on archery skills (Y), with the following test criteria.

H0: x3y = 0

H1: x3y 0

Based on the calculation results, the path coefficient is 0.266 with a p value of 0.022 <0.05, so reject H0 and accept H1 so that there is a direct effect of Core stability on archery skills. The contribution value of Core stability is $(0.520)^2$ x 100% = 7.07%

Direct Effect of Arm Length (X1) on Core Stability (X3)

Hypothesis 4 is that there is a direct effect of arm length (X1) on core stability (X3), with the following test criteria.

H0: x1x3 = 0

H1: x1x3 0

Based on the calculation results, the path coefficient is 0.399 with a p value of 0.040 <0.05, so reject H0 and accept H1 so that there is a direct effect of arm length on Core stability. The contribution value of the arm length is $(0.399)^2$ x 100% = 15.9%

Direct Effect of VO2Max (X2) on Core Stability (X3)

Hypothesis 5 is that there is a direct effect of VO2Max (X2) on Core stability (X3), with the following test criteria.

H0:x2x3=0

H1: x2x3 0

Based on the calculation results, obtained a path coefficient of 0.511 with a p value of 0.011 <0.05, then reject H0 and accept H1 so that there is a direct effect of VO2Max on Core stability. The contribution value of VO2Max is $(0.511)^2$ x 100% = 26.1%

Indirect Effect of Arm Length (X1) on Archery Skills (Y) through Core Stability (X3)

Hypothesis 6 is that there is an indirect effect of arm length (X1) on archery skills (Y) through core stability (X3), with the following test criteria.

H0: x1x3y = 0

H1: x1x3y 0

Based on the calculation results, the indirect effect value is 0.399 x 0.266 = 0.106, so reject H0 and accept H1 so that there is an indirect effect of arm length on archery skills through Core stability. The contribution value of the arm length is $(0,106)^2$ x 100% = 1.1%.

Based on the direct and indirect effects, the total effect of arm length on archery skills is 0.399 + 0.106 = 0.505.

Indirect Effect of VO2Max (X2) on Archery Skills (Y) through Core Stability (X3)

Hypothesis 7 is that there is an indirect effect of VO2Max (X2) on Archery Skills (Y) through Core stability (X3), with the following test criteria.

H0: x2x3y = 0

H1: x2x3y 0

Based on the calculation results, the indirect effect value is 0.511 x 0.266 = 0.138, so reject H0 and accept H1 so that there is an indirect effect of VO2Max on archery skills through Core stability. The contribution value of VO2Max is $(0.138)^2$ x 100% = 1.9%. Based on the direct and indirect effects, the total effect of VO2Max on archery skills is 0.511 + 0.138 = 0.649.

CONCLUSION

Based on the results of the tests and calculations of this study, the following conclusions were obtained.

a. There is a direct effect of arm length (X1) on archery skills (Y) in archery athletes.
b. There is a direct effect of VO2 Max (X2) on archery skills (Y) in archery athletes.
c. There is a direct effect of Core Stability (X3) on archery skills (Y) in archery athletes.
d. There is a direct effect of Arm Length (X1) on Core Stability (X3) in archery athletes.
e. There is a direct effect of VO2 Max (X2) on Core Stability (X3) in archery athletes.
f. There is an indirect effect of Arm Length (X1) on archery skills (Y) through Core Stability (X3) in archery athletes.
g. There is an indirect effect of VO2 Max (X2) on archery skills (Y) through Core Stability (X3) in archery athletes.

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